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Vehicle door

The invention relates to a vehicle door consisting of an interior shell and an outer shell adjacent to both sides of an interior door space.

5 With known vehicle doors of this type, the interior shell and the exterior shell consist of deep-drawn parts of metal sheet (interior metal sheet and exterior metal sheet) which are connected with each other along the edge; for example, by folding the exterior metal sheet around the edge of the interior metal sheet. While the outer metal sheet is primarily manufactured in accordance with a visual point of view, such as shape and color, the interior metal sheet has the

10 function of a support structure which is connected via hinges and a lock with a door frame of the vehicle and furthermore contains functional parts of the vehicle door, such as a window-regulator arrangement, a speaker, airbag and the like. Thus, the interior metal sheet has to serve a multitude of functions which, in part, require conflicting measures. Therefore, the attachment of a

15 multitude of component parts to the interior metal sheet is inescapable, wherein the component parts take over a part of the door functions, such as guide rails of a window-regulator arrangement which makes possible the up and down movement of the transport slide element of a window which can be raised and lowered. The multitude of required component parts makes the

mounting of such a vehicle door expensive and increases the weight of the vehicle door.

5 Based thereon, it is the problem of the invention to create a comparatively lightweight vehicle door from functionally suitable component parts. The number of structural components is to be reduced, if possible.

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10 As a solution to this problem, a vehicle door with the characteristic of Claim 1 is proposed. Such a vehicle door has a frame structure which is covered at least on one of its sides with an inner or outer shell respectively, particularly panel elements; said frame structure consists at least in part of a profile bar, which forms at least part of a U-shaped structure as viewed from the side, for instance by bending said profile bar, and which U-shape opens towards an outer edge of the vehicle door, particularly to its top. Thereby, the U-shaped structure may take on at least a substantial part of the support and reinforcement function of the vehicle door. It may be closed to form a complete loop as well.

20 However the U-shaped structure does not only provide a high degree of stability, especially rigidity, of the vehicle door, for instance in the threshold area located at the lower edge of the door as well as its vertical and preferably parallel lateral extensions where it can accommodate the forces of the door hinges and of the door lock. The U-shaped structure - also - accommodates or even replaces essential components of a window opener arrangement -
25 hereinafter called a window-regulator arrangement.

In a first embodiment, the two profile portions of an upright U extend approximately parallel and provide guide elements for a window-regulator arrangement, so that known slide elements can be completely omitted.
30 Preferably, the U-shaped structure also accommodates a window-regulator drive; in particular, an electric motor. Furthermore, it can serve as guide

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element for driving elements of the window-regulator, such as flexible pressure- and traction means, particularly for the raising and lowering of the window and, in this way, replace the function of Bowden wires, or form tubes in which drive cables are led from the motor to the guide elements of the window
5 regulator. Thus, such a frame structure becomes multifunctional and by saving on structural components makes possible a reduction in the weight of the vehicle door.

A particularly elegant mounting and guide element of a vehicle window which
10 can be raised and lowered, having a favorable influence on the C_w -value of the vehicle, is achieved by coupling members which connect the window with the window guide element provided on the U-shaped profile bar. With such coupling members it is, for example, possible to freely select the position of the window with respect to the exterior panel of the vehicle door; in particular, to
15 shift the position of the window pane relatively far toward the exterior of the vehicle door. By gluing the coupling members onto the interior side of the window, particularly in the area of the edge of such a window edge molded or sprayed with a suitable synthetic material, such as polyurethane, the window guide grooves can be omitted. Coupling members, in accordance with the
20 invention, may also be in the form of straight profile rails which grip into the guide elements provided on the frame structure, particularly in a manner corresponding to their shape.

Furthermore, coupling members of the invention may also be adjustable
25 besides being rigid, so that the position of the window with respect to the guide rails provided on the frame structure can be changed, particularly in a lateral direction. In this way, the window pane can be transported in the closed state into a plane aligned with the outer skin of the door. In order to open the window, the same is moved laterally out of its plane in the closed state in order
30 to subsequently be lowered completely or partially into the interior of the door. Such a window-regulator arrangement is of independent inventive significance.

Furthermore, such a vehicle door simplifies the structural type and the mounting of important functional parts, such as window-regulator arrangements, door hinges and door lock, wherein the frame structure is in a better position than the known metal sheets of doors to carry out a dual function, thereby saving on structural components, weight and/or mounting costs.

Inasmuch as the term "frame structure" is used, this means, in the sense of the invention, that struts or strut-like structural components, leaving between them free spaces or openings, are connected with each other. The "oblong profiles," from which the frame structure formed, may be struts stamped from a plate, such as a metal sheet, and possibly additionally formed by a deep-drawing process; the struts being interconnected. The "oblong profiles" may be as well rods, at first in straight form and produced, for example, in an extrusion or continuous casting process, which are reshaped and/or joined by bending and/or by being connected with each other to form the desired frame structure. Such profiles, produced in the extrusion or continuous casting process, are also suited as frame elements for the vehicle door when they are provided as a support structure, especially in the A-, B- and/or C-column of the vehicle body, at least at one side of the vehicle door.

Sub 03 → Inasmuch as the term "U-shaped-structure" is used, this means, in the sense of the invention, that this structure forms at least part of a frame structure 10 and a profile bar 10A is part of said U-shaped-structure at least at one of its sides. Said U-shaped-structure maybe completed to form a complete loop necessary. The U-shape may open toward any edge of the door but preferably opens to the top. The open edge maybe closed by a further profile bar or element, e.g. stamping, to form a completed loop. Said U-shaped-structure maybe formed in different ways, particularly by bending a profile bar into a U-shaped form; however, the legs of the U-shape maybe connected together by a multiplicity of

other elements (instead of a bended curve element), e.g. by other or same profiles, other stampings or moldings or die-castings, with appropriate fixings in the corner areas as required. The oblong profile used for the U-shaped-structure may also be discontinuous, particularly in the vicinity of the motor of a window-regulator or maybe joined by one or several other elements which form the discontinuity, e.g. a separate mounting plate, molding or die-casting fitted, which may join discontinuous parts of the profiles together.

The above-mentioned, as well as the claimed component parts to be used in accordance with the invention and described in the examples, are not subject to any special exceptional conditions with respect to their size, shape, material selection and technical concept, so that the selection criteria known in the area of application can find application in an unlimited manner.

Additional details, characteristics and advantages of the subject invention can be gathered from the subclaims as well as from the subsequent description of the accompanying drawing in which preferred examples of the vehicle door of the invention is shown. In the drawing,

Figure 1A shows a frame structure of a vehicle door consisting of oblong profiles in sideview;


Figure 1B shows an interior shell serving as a rim panel for the same vehicle door;

Figure 1C shows an exterior shell serving as an exterior panel for the same vehicle door;

Figure 1D shows a horizontal cross section along the section line ID-ID of the vehicle door in accordance with Figure 1A to Figure 1C;

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- Figur 2 shows part of an U-shaped element for a frame structure, according to Figure 1A, with an alternative profile cross section in perspective view;
- 5 Figure 3 shows an alternative cross sectional form of an oblong profile with window-regulator guide element in cross section;
- Figure 4 shows an alternative profile cross section with window guide element;
- 10 Figure 5 shows an additional alternative profile cross section with window guide element;
- Figure 6 shows a vehicle door in schematic side view with a window-regulator drive;
- 15 Figure 7 shows an alternative embodiment of a vehicle door in schematic side view with a window-regulator drive and
- 20 Figure 8 shows an alternative embodiment of a frame structure with window guide element in horizontal cross section.

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From Figures 1A to 1C, the three main components of a vehicle door in accordance with the invention can be gathered, namely a frame structure 10 (Figure 1A), formed from oblong profiles 10A to 10D, an external view of an interior shell or trim panel 12 (Figure 1B), wherein the interior shell covers the lateral surface of the frame structure 10 visible in Figure 1A, as well as an interior view of an exterior shell 14 (Figure 1C), wherein the exterior shell covers the lateral surface opposite the lateral surface visible in Figure 1A. A horizontal cross section along the line ID-ID in the lower area of the door can be seen in Figure 1D (profile 10B being deleted for clarity reasons).

The frame structure 10, shown in Figure 1A, consists of a total of four profile sections 10A to 10D, produced in an extrusion process, with the cross section visible in Figure 2. The main component is a U-shaped profile bar 10A, formed by bending, which has parallel, approximately vertically extending lateral extensions and an approximately horizontally extending base extension and wherein a groove 16A surrounding a window-regulator guide element 16, visible in Figure 2, opens toward the interior curvature of the U-shape. The profile sections 10B to 10D, extending essentially diagonally, i.e. horizontally to diagonally, serve to reinforce the frame structure formed in the core of the U-shaped structural component 10A. They are connected with the U-shaped rod 10A in a rigid angle manner, for example, by welding or by any other known method.

As a whole, the frame structure 10 represents the structural components determining the strength and the rigidity of the vehicle door. Therefore, it is possible to make relatively small demands regarding material selection and the strength of the interior shell 12 and the exterior shell 14. With respect to rigidity, they basically need only meet the requirements of the main function, which is to close off the interior space 26 of the door in an especially sealing manner and they must satisfy the requirements regarding the resistance to deformation and fatigue durability with respect to typical lateral stresses from the interior side of the vehicle or the exterior side of the vehicle.

While in the example according to Figures 1A to 2 the interior shell 12 already serves as an interior or trim panel of the vehicle door which, for example, is produced from a suitable non-metal, the interior covering of the frame structure 10 may, for example, also consist of a deep-drawn, so-called interior metal plate whose strength suffices for accommodating heavier or more greatly stressed functional components, particularly to serve as a pre-fabricated support module for a multitude of functional components, wherein an additional interior or trim panel satisfies the visual expectations and those regarding the

interior design. Naturally, such a support module, if a suitable material is selected, may also consist of a non-metal. On the other hand, it is possible to use the frame structure 10 in such a way, that functional components, such as an airbag, speaker, outside mirror and the like are connected to the frame structure itself, so that the interior shell 12 has more of a panel function than a support function. Other functional components, in particular the door hinges, are mounted as a rule only to the frame structure 10 in order to achieve an advantageous frictional connection.

10 The exterior shell 14, which may consist of metal sheet, a synthetic material or other suitable exterior panel material, will accommodate as a rule no functional components or only those which are subjected to little mechanical stress. At the same time, it is possible, for example, to provide lateral impact protection as a component of the exterior shell 14 on the latter's inside instead of
15 integrating it in the frame structure 10A.

Such a vehicle door, while having a high degree of strength, may be manufactured having a comparatively light weight, particularly with a frame structure of aluminum or another light metal or of carbon fibers or other very strong but light weight materials. The same oblong profiles, from which the frame structure 10 is formed, wherein also varying profile cross sections are possible for the individual frame structure components, may, depending on the layout, also form the exterior frame, i.e., the frame of the vehicle door which is fixed to the body of the automobile, particularly the support columns (A-, B- and/or C-column), provided laterally with respect to the vehicle door or may form their supporting basic structure, thereby reducing the multitude of vehicle door components.

30 The other aspect of the vehicle door, in accordance with Figures 1A to 2, is the integration of a window-regulator arrangement for a window pane 22 which can be raised and lowered into the frame structure 10. In the preferred embodiment

according to Fig. 2, an electrically driven version is used: the window-regulator motor 18 is supported by the approximately horizontal U-extension of the U-shaped structure 10A and is tightly connected with it, for example, by screws, and is possibly in part introduced into the profile 10A. Drive cables serving as pressure/traction elements 20 for the raising and lowering of the window pane extend from the window-regulator drive motor 18 through the window-regulator guide elements 16, formed in the profile 10A, which may be adapted to the cross section of the drive cable.

While Figure 1A provides only a single window-regulator guide element 16 in central arrangement, in the cross sectional variation according to Figure 2, two such window-regulator guide elements are provided, so that the pressure/traction element for each window side is guided along its entire length, respectively, and is kept in the profile 10A, - not only the section of the drive cable extending from the motor 18 to the window 22, but also the drive cable section extending out of the respectively opposite motor side which, while the window is lowered, is long and when the window is raised, is short to the point of having completely disappeared. These or other, possibly additional guide grooves may, as a replacement for Bowden wire tubes, also serve for other functional parts of the vehicle door.

Such a window-regulator arrangement integrates the function of the movement and the guidance of the window 22 into the frame structure 10, wherein the actual window pane may be connected via coupling members 24 with the drive elements, especially with the pressure/traction element 20, as is indicated in Figure 1D. These and similar window-regulator arrangements can also be gathered from the subsequently described Figures 3 to 8.

Figures 3 to 5 present additional alternatives to Figures 1D and 2 for the profile cross section design of the U-shaped profile bar of a frame structure 10 having the guide elements 16. In the example according to Figure 4, an edge guide

element 16B of the window 22 is already integrated in the profile 10A. For this reason, the window can also be guided directly by the profile 10A.

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Such a profile, as well as the profiles according to Figures 3 and 5, may have, at least partially, viewing surfaces in the vehicle door, so that a complete or partial profile trim panel can be omitted, which may be advantageous, particularly for the upper part of the frame serving as a window panel guide frame in the examples of a vehicle door shown in Figures 1A, 6 and 7, since side coverings of the frame structure as such are not absolutely necessary in this area.

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In the embodiments according to Figures 3 and 5, it is possible to align the exterior surface of a window pane 22 with an exterior surface of the profile 10A, so that between the window pane and the window frame, steps can be avoided which are disruptive visually and/or with respect to air flow. In the example according to Figure 5, the window pane 22 has toward the interior side a large contact surface with respect to the profile 10A which, not expressly shown in the drawing, can be used as a sealing surface; for example, for accommodating a sealing profile. A visually very advantageous window coupling with a pressure/traction element 20 is achieved in this example by means of a coupling member 24 which grips from outside through a slotted area of the guide element 16 into the profile 10A and there is connected with the pressure/traction element. An angular area of the coupling member 24, extending out of the guide element 16 parallel to the window 22, makes possible its connection with the window; for example, by gluing. Such a coupling member may be very short in the direction of movement, in particular, several such coupling members may be provided along the guide element 16. Advantages with respect to stability, however, are also possibly brought about by an oblong coupling member, extending along the guide element 16, which member is connected with the window pane 22 along a greater or even the entire length of the guide element of the window.

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Coupling members 24 may be components of the window pane 22 and connected with the pressure/traction element 20, which will be connected with the window pane 22, or they may be separate components which are or will be connected with both the pressure/traction element and the window pane.

The characteristic feature of the example according to Figure 3, as compared with the preceding embodiments, consists in a different coupling member 24. This not only makes possible a drive connection between the pressure/traction element 20 and the window 22 in the direction of raising and lowering, but also in the lateral direction of the window 22. While in the example according to Figure 5 an aligned arrangement of the window pane with respect to the window frame in the upper part of the window is possible while the window edge, abutting against the interior space of the door, requires a sill protruding toward the exterior, it is possible according to the example of Figure 3 to realize a vehicle door in which the window pane and the parts of the exterior panel of the door adjacent to the window pane in its closed state can be aligned on all adjacent sides with the window 22, and accordingly, in the area of the sill as well.

For this purpose, the window pane 22, in the example according to Figure 3, is moved laterally by a lateral swiveling of the coupling members 24, out of its thrust position, which is aligned with the exterior panel, and is subsequently lowered into the interior space of the hollow door. The process is reversed during the raising and subsequent closing of the window. This aspect of the invention is - also independent of a U-shaped profile bar - of independent significance.

Figure 8 shows an additional embodiment of a window arrangement and window guide element of a vehicle door that is possible to realize on a window frame above the interior space of the door, i.e. above the door sill without

sacrificing the quality of the guide element, the seal and/or strength of the window. In the case of the example shown in Figure 8, the coupling members 24 and oblong door profile components 10A are formed so as to correspond to each other and form along a predeterminable length, a good and also comparatively tight window guidance element. Actually, it suffices when the coupling member 24 is located entirely inside the interior of the door, also when the window is closed, i.e. it does not extend into the glass area visible from the outside. However, it is also possible to arrange the coupling member 24 entirely or partially in the visible area of the window, i.e. when it is closed. Such a window is particularly easy to install in the vehicle door from above. The coupling member 24 represents a reinforcement element of the window pane and may be glued, for example, on the glass of the window pane in a known way; for example, by means of polyurethane, or may be bonded with same by spraying along the edge of the window.

In the case of windows made of a deformable material, for example, polycarbonate or acrylic, the coupling member may also be a one-piece component of the window. The profile of the coupling member itself or a profile which has been altered in its cross section and which connects to the coupling member may also surround the window pane (in its closed position) along its lateral as well as upper edge in order to achieve an increase in strength. In the same way, it is possible to shape the coupling member 24 by means of a shaping process or the like; for example, an exterior groove 30, in such a way that it can accommodate a window seal and/or, in the closed state, grip into corresponding frame components of the vehicle body, thus giving to the window pane special support while in the completely closed state, particularly in its upper area. This is advantageous not only during high speeds, but also possibly as a protection against break-ins and for other reasons.

Also, the embodiment according to Figure 8 makes it possible to mount the window in such a way that, as viewed from the outside, it has a frameless

appearance. As can be seen on the right in Figure 8, next to the vehicle door shown in section on the left, another vehicle door or a vehicle body area may abut against a fixed window pane, wherein the adjacent window panes 22 are aligned with each other, leaving only a small crack. For the containment
5 support and possible movement of the window, similar structural components as with the vehicle door shown left in Figure 8, may be used.

It can be seen in Figure 6 that the means for moving the window; in particular, drive cables, also in the form of Bowden wires, can extend at least in part
10 outside the oblong profiles and/or may also be loosely placed inside the oblong profiles.

Figure 7 shows another vehicle door with a window-regulator arrangement of independent inventive significance, wherein typical Bowden controls (traction
15 element 20A), which are guided around deflection rolls or guide pulleys (deflection elements 20B) for the purpose of operating windows and are moved by a conventional window-regulator drive 18, are provided. The traction elements are connected to the window pane 22 by means of clamping devices or the like in a known manner. Here, a window-regulator arrangement of typical construc-
20 tion is involved. The characteristic feature in the embodiment according to Figure 7 consists in that the window-regulator guide elements are completely omitted because parallel profile bars 10A, 10E guide the parallel window edges which are facing each other, wherein these profiles form structural components of the door, particularly a frame structure 10, as described in connection with
25 the other examples.

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Reference symbols

10	frame structure
10A	U-shaped profile bar
5 10B	oblong profile
10C	oblong profile
10D	oblong profile
10E	oblong profile
12	interior shell
10 14	exterior shell
16	window-operating guide element
16A	groove
16B	edge guide element
18	window-operating drive motor
15 20	pressure/traction element
20A	traction element
20B	deflection roll
22	window pane
24	coupling member
20 26	interior door space
28	connection means [bonding means]
30	groove